HYBRID CASCADE MODEL-BASED PREDICTIVE CONTROL SYSTEM

Abstract of the Disclosure

A hybrid cascade Model-Based Predictive control (MBPC) and conventional control system for thermal processing equipment of semiconductor substrates, and more in particular for vertical thermal reactors is described. In one embodiment, the conventional control system is based on a PID controller. In one embodiment, the MBPC algorithm is based on both multiple linear dynamic mathematical models and non-linear static mathematical models, which are derived from the closed-loop modeling control data by using the closed-loop identification method. In order to achieve effective dynamic linear models, the desired temperature control range is divided into several temperature sub-ranges. For each temperature sub-range, and for each heating zone, a corresponding dynamic model is identified. During temperature ramp up/down, the control system is provided with a fuzzy control logic and inference engine that switches the dynamic models automatically according to the actual temperature. When a thermocouple (TC) temperature measurement is in failure, a software soft sensor based on dynamic model computing is used to replace the real TC sampling in its place as a control system input. Consequently, when a TC failure occurs during a process, the process can be completed without the loss of the semiconductor substrate(s) being processed.